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Original Article

Bowel Preparation for Colonoscopy: A Randomized Controlled Trial Comparing Polyethylene Glycol Solution, One Dose and Two Doses of Oral Sodium Phosphate Solution

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OBJECTIVES: To compare three bowel preparation regimens for colonoscopy in terms of the quality of preparation, the side effects and patient acceptance.

METHODS: A total of 299 patients who underwent colonoscopy were randomized to three bowel preparation regimens: polyethylene glycol solution (n = 106), or a single dose (n = 92) or two doses (n = 101) of sodium phosphate solution. The colonoscopists who recorded the quality of bowel preparation were blind to the preparation regimens. The discomforts associated with bowel preparation and patient acceptance of the preparation were also recorded.

RESULTS: Two doses of sodium phosphate solution achieved significantly better bowel preparation than polyethylene solution or a single dose of sodium phosphate solution ($p < 0.05$). Although two doses of sodium phosphate solution was associated with more dizziness and anal irritation, patients preferred preparation with sodium phosphate solution than with polyethylene glycol solution. Of the 69 patients in the sodium phosphate solution groups who had prior experience of bowel preparation using polyethylene glycol solution, 55 patients (80%) stated that they preferred sodium phosphate solution.

CONCLUSION: Two doses of sodium phosphate solution achieved better bowel preparation than polyethylene glycol solution and was more acceptable to patients. A single dose of sodium phosphate did not achieve similar bowel preparation to two doses of the solution. [*Asian J Surg* 2004;27(2):120–4]

Introduction

Good bowel preparation is essential for adequate colonoscopy, allowing visualization of the details of the colonic mucosa and providing a safe environment for therapeutic procedures. The bowel preparation regimen should be rapid, safe, simple, effective, and acceptable to patients. In 1980, Davis et al introduced a polyethylene glycol (PEG)-based isotonic solution for peroral antegrade lavage of the colon.[1] This has become the most common bowel preparation solution for colonoscopy as well as for elective colorectal surgery. However, the consumption of a large volume of PEG solution within a short period of time is not easily tolerated. The use of oral sodium phosphate solution has been reported to provide adequate cleansing with a smaller amount of fluid and is more acceptable to patients.[2] The usual divided dose of oral sodium phosphate solution may be inconvenient to some patients. In this prospective randomized trial, three bowel preparation

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regimens, PEG solution, a single dose, and two doses of sodium phosphate solution, were compared for the quality of bowel preparation, side effects and patient acceptance.

Patients and methods

Patients aged more than 18 years and scheduled for elective colonoscopy were enrolled in this study. Those with intestinal obstruction, delayed gastric emptying, renal impairment with a serum creatinine of more than 0.2 mmol/L, congestive heart failure or myocardial infarction within 6 months, massive ascites, or pregnancy were excluded.

After informed consent was obtained, patients were randomized to one of the three bowel preparation regimens. In Group A, patients were given 2 to 4 L of PEG solution at 18:00 the evening before the colonoscopy if the appointment was scheduled for the next morning. If the colonoscopy was performed in the afternoon, PEG solution was given at 08:00 on the morning of the examination. In Group B, patients received 45 mL of sodium phosphate solution in the form of Fleet® phosphosoda (CB Fleet Co, Inc, Lynchburg, VA, USA) with half a glass of clear fluid at 18:00 the evening before the colonoscopy if the appointment was scheduled for the morning. This was followed by at least three glasses of fluid in the following hour. If colonoscopy was performed in the afternoon, sodium phosphate solution was taken at 06:00 on the morning of the examination. In Group C, patients received two doses of sodium phosphate solution (45 mL each dose) at 18:00 the day before and 06:00 on the day of colonoscopy. After each dose of sodium phosphate solution, at least three glasses of fluid were taken in the following hour. If the examination was in the afternoon, the morning dose was given at 09:00.

The side effects associated with the bowel preparation, such as abdominal pain, abdominal bloating, nausea, vomiting and dizziness, were recorded by a nurse (LW). She also recorded patient acceptance of the bowel preparation regimen and whether the preparation was completed. Colonoscopy was performed by colon and rectal surgeons who were blinded to the bowel preparation regimens. The quality of bowel preparation was classified as excellent (no residual fluid, all the mucosa could be visualized), good (clear liquid that could be aspirated easily), fair (liquid faeces), and poor (solid faeces present). Completion of the colonoscopy and any complications were also recorded.

Data were entered into the computer database using SPSS version 9.0 (SPSS Inc, Chicago, IL, USA). The Chi-squared test or Fischer's exact test was used for analysis of categorical and ordinal variables. A p value of less than 0.05 was considered statistically significant. When the sample size was estimated, it was found that 91 patients in each group are needed in order to show a 20% improvement in the quality of bowel preparation (from 60% good or excellent preparation to 80%), with a power of 80% and a significance level of 5%.

Results

A total of 299 patients (160 males and 139 females) were included in the study, 106 in Group A, 92 in Group B and 101 in Group C. The mean age ± standard deviation was 58.1 ± 15.0 years. There was no difference in the gender and age distribution among the three groups. Ten patients in Group A, three in Group B, and three in Group C did not complete the bowel preparation regimens. Complete colonoscopy to the caecum or terminal ileum was achieved in 262 patients. The reasons for failure of complete colonoscopy were obstructing lesions (n = 15), technical difficulty (n = 12), poor preparation (n = 6), and patient intolerance of the procedure (n = 4).

The quality of the preparation is shown in Table 1. A significantly greater proportion of patients in Group C (76%) than in Group A (56%) or Group B (51%) had good or excellent bowel preparation ($p < 0.05$).

The discomforts resulting from the bowel preparation regimens are shown in Table 2. Most were mild; moderate to severe side effects accounted for less than 5% of each category of morbidity. Patients in Group C had significantly more dizziness and anal irritation than those in Group A. There was no difference in abdominal pain, vomiting, abdominal bloating or nausea between Groups C and A. A single dose of sodium phosphate solution (Group B) was associated with less anal irritation and vomiting than two doses of sodium phosphate solution (Group C).

Table 1. Quality of bowel preparation with different bowel preparation regimens

Quality of preparation	Group A	Group B	Group C
Excellent	12	12	16
Good	47	37	61
Fair	39	32	22
Poor	8	11	2
Total	106	92	101

Group A: polyethylene glycol solution; Group B: single 45 mL dose of sodium phosphate solution; Group C: two 45 mL doses of sodium phosphate solution. A vs C: $p < 0.05$; B vs C: $p < 0.05$.

Of the 106 patients in Group A, 20.8% (22) were reluctant to use a similar bowel preparation regimen again, while only 9.9% (10) of the 101 patients in Group C were unwilling to repeat the regimen. The difference was statistically significant ($p = 0.03$).

Of the 69 patients who received sodium phosphate (both single and two doses) who had undergone previous colonoscopy with preparation using PEG solution, 79.7% (55) claimed that they preferred sodium phosphate solution, four claimed that sodium phosphate solution was worse, and 10 found no difference between PEG solution and sodium phosphate solution.

Table 2. Discomforts of different bowel preparation regimens

	Group A	Group B	Group C	*p*	
				A vs C	B vs C
Nausea				0.83	0.12
None	70	68	63		
Mild	32	23	33		
Moderate to severe	4	1	5		
Vomiting				0.07	0.03
None	96	85	80		
Mild	9	6	18		
Moderate to severe	1	1	3		
Pain				0.62	0.32
None	88	79	80		
Mild	16	12	17		
Moderate to severe	2	1	4		
Bloating				0.1	0.18
None	62	75	72		
Mild	41	16	25		
Moderate to severe	3	1	4		
Dizziness				0.01	0.13
None	97	80	78		
Mild	9	12	21		
Moderate to severe	0	0	2		
Anal irritation				0.02	0.05
None	94	80	74		
Mild	10	11	23		
Moderate to severe	2	1	4		

Group A: polyethylene glycol solution; Group B: single 45 mL dose of sodium phosphate solution; Group C: two 45 mL doses of sodium phosphate solution.

In this study, 119 patients had colonoscopy in the morning and 180 were examined in the afternoon. Although we did not initially intend to study the results of the timing of the examination, the quality of bowel preparation was much better in those who were examined in the afternoon after bowel preparation in the morning (Table 3). When the quality of preparation was analysed in the three groups separately, significantly better preparation was found in colonoscopies performed in the afternoon in patients in Group B. In Groups A and C, better preparation was achieved in the afternoon examination, but this did not reach statistical significance (Table 4).

Table 3. Quality of preparation in relation to the timing of the examination

Quality	Morning examination	Afternoon examination
Excellent	11	29
Good	55	90
Fair	38	55
Poor	15	6
Total	119	180

$p = 0.009$

Table 4. Quality of preparation of the three groups in relation to the timing of examination

	Morning examination	Afternoon examination	*p*
Group A			0.21
Excellent	2	10	
Good	18	29	
Fair	14	25	
Poor	5	3	
Group B			0.05
Excellent	4	8	
Good	10	27	
Fair	11	21	
Poor	8	3	
Group C			0.15
Excellent	5	11	
Good	27	34	
Fair	13	9	
Poor	2	0	

Group A: polyethylene glycol solution; Group B: single 45 mL dose of sodium phosphate solution; Group C: two 45 mL doses of sodium phosphate solution.

Discussion

The success of colonoscopy depends on good bowel preparation to allow adequate visualization of the details of the mucosa and to provide a safe environment for polypectomy with electrocautery. Since its introduction by Davis et al in 1980,[1] PEG solution has become the most commonly used bowel preparation solution because it allows rapid and safe bowel preparation without significant fluid and electrolyte disturbance. It has virtually replaced the conventional regimens, which required 2 to 3 days of fluid diet, laxatives and enemas. However, the large volume of PEG solution that must be consumed within a short time reduces patient acceptance and, hence, compliance. It has been shown that 5% to 15% of patients cannot finish bowel preparation with PEG solution.[3] The addition of flavour to the PEG solution does not improve tolerance.[4]

With the introduction of sodium phosphate solution, bowel preparation may be performed with a relatively smaller volume of fluid. Most studies show that the use of sodium phosphate solution can achieve equivalent or superior bowel preparation compared to PEG.[2,5,6] In this prospective study, we showed that two doses of 45 mL sodium phosphate solution achieved better bowel preparation than PEG solution ($p = 0.015$). We also studied whether a single dose of sodium phosphate solution could produce comparable bowel preparation to the conventional two-dose regimen; the two-dose regimen was significantly better than a single dose of 45 mL sodium phosphate solution ($p = 0.003$). Unal et al[7] found a similar result when they compared 45 mL to 90 mL of phosphosoda; our study confirmed their result that a single dose of 45 mL sodium phosphate solution did not achieve similar bowel cleansing to two doses. Thus, the two-dose regimen should remain the standard regimen for bowel preparation.

The tolerance of patients for the small-volume preparation of sodium phosphate solution has been reported to be better than that for PEG. In this study, we found that most discomforts were mild. There were no significant differences in nausea, vomiting, abdominal pain or bloating between patients using PEG and two doses of sodium phosphate solution. However, there was more dizziness and anal irritation in patients receiving two doses of sodium phosphate solution than in patients receiving one dose. Dizziness in patients receiving sodium phosphate solution has been reported in other series.[5] Vanner et al found that the dizziness was not associated with a change in postural blood pressure or pulse rate.[2] Even though more symptoms were reported in patients receiving sodium phosphate solution, patients found that sodium phosphate solution was more acceptable, with only 9.9% of patients claiming that they were reluctant to use sodium phosphate again for bowel preparation compared to 20.8% of patients who were reluctant to repeat bowel preparation with PEG solution.

The acceptance of sodium phosphate solution was further demonstrated in patients who had previously undergone preparation with PEG. Of the 69 patients in the sodium phosphate solution group who had previous experience with PEG solution, 79.7% preferred sodium phosphate solution.

The importance of the timing of preparation was addressed by Church[8] and Frommer.[9] Church showed that PEG solution consumed in the morning for colonoscopy in the afternoon was associated with better preparation.[8] Although our study was not initially intended to investigate the quality of preparation in relation to the timing of preparation, it was found that, when all the patients were considered, preparation was better in those with appointments in the afternoon. In patients receiving either PEG or two doses of sodium phosphate solution, there was a tendency for better preparation in those undergoing colonoscopy in the afternoon, although it did not reach statistical significance. In patients receiving a single dose of sodium phosphate solution, bowel preparation in the morning for colonoscopy in the afternoon achieved significantly better bowel preparation. Thus, the quality of bowel preparation is better if bowel cleansing is done in the morning instead of the day before colonoscopy. Further randomized, controlled trials are necessary to validate this finding.

In conclusion, from this randomized trial, two 45 mL doses of phosphosoda achieved better bowel preparation for colonoscopy than a single 45 mL dose of phosphosoda or PEG solution. Phosphosoda solution was also more acceptable to patients than PEG solution. There was a tendency towards better quality preparation in patients who underwent colonoscopy in the afternoon when bowel preparation was performed on the morning of the examination.

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